Scanning the Issue

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When we proposed this special issue on the automobile to the Proceedings editorial board, the feedback we received was indeed quite revealing what the automobile has to become today. It is indeed a system, complete in many respects with complex controls, communications and computing environment. On the other hand, the automobile today is but a *component* in an increasingly information rich roadway infrastructure. Any meaningful review of the growth of electronic driven intelligence in the automobile, therefore, had to be placed in the context of the growth in intelligence in the larger transportation system. The collection of papers that have been selected for this special issue, cover a range of topics that review advancements in automobiles both as "move alone" systems and as "connected" components in a broader intelligent transportation system (ITS).

This issue covers topics that review advancements in automobiles both as independent, stand-alone systems and as "connected" components which comprise a broader intelligent transportation system (ITS).

The papers span a number of interdependent themes that include: architecture; systems; controls & communications, computing and embedded computers, safety, and intelligent vehicles. Even with the breadth of papers in this issue, we realize that there are a number of topics that are not included. Therefore, to ensure general coverage and, as a prolog to this special issue, we have dedicated the first article under the auspices of "Scanning the Technology." This introductory article mainly overviews the progress of electrical, electronics, software, and other relevant technologies that shape the modern automobile. Some of these technologies are described in more detail in the articles that comprise this special issue.

Following this introductory article by the guest editors, the first invited paper is entitled "Control, Computing and Communications: Technologies for the Twenty-first Century Model T." This paper, which is presented by Cook, Kolmanovsky, McNamara, Nelson, and Prasad provides a comprehensive systems review of modern automobiles. The major underlying sub-systems—powertrain, chassis electronics, body electronics, infotainment—and their vehicle-level interactions to deliver the safety, drivability, fuel-economy, tail-pipe emissions, and entertainment features are described in terms of the affect of recent advancements in the fields of electronics controls, communications and computing, including software. The paper also includes an overview of a combined vehicle and off-vehicle infrastructure that will define a large part of the personal mobility experience of tomorrow.

As software-based functionality is at the root of various challenges in automotive industries, the next paper is entirely dedicated to the issue of software engineering aspects of automotive technology. This paper, authored by Broy, Krüger, Pretschner, and Salzmann, presents the role of computing, communications, and control systems in delivering automotive functions that meet both regulatory and consumer demands. The paper also provides a valuable insight to the growth of software engineering

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in the automobile industry and those working in the field. It guides readers through different software engineering subjects and how they connect in both research and practice, as well as how these subjects build on each other by specifying what we consider to be the most pressing problems.

Emerging advanced intelligent vehicle technologies are central to industry and government plans to improve vehicle safety and reduce fatalities. The next two papers in this special issue are concerned with coverage of vehicle safety and transportation system capacity. The paper by McCall and Mohan entitled, "Driver Behavior and Situation Aware Brake Assistance for Intelligent Vehicles," describes how information about driver behavior and vehicle situation can be used for braking assistance. The scope of the paper in some ways is very large, in that the system described has numerous complex technical components. One of the most important aspects of the paper is the conceptualization of the braking assist system as a function that maps driver intent to brake and the situational need for the system to alert the driver. The work impacts vehicle safety, collision avoidance, and human computer interaction by providing a framework to generate different levels of warning. This is based not only on the vehicle and surroundings, but also on the driver. The authors demonstrate how these types of systems can be trained and evaluated, as well as how they could be incorporated into active safety systems. It is often suggested that the trend of increasing functional sophistication in passive safety will continue with synergistic integration of emerging active safety systems. This is the main focus of the next article by C.-Y. Chan entitled "Trends in Crash Detection and Occupant-restrained Technology." The paper provides a perspective on the evolution of automotive restraint technology and the author offers a system-level overview of design trends that will likely prevail in future developments of automotive safety systems.

On the issue of advanced intelligent vehicle technologies, our next paper reports on recent progress in autonomous vehicle systems, particularly in conjunction with the DARPA Grand Challenges initiative. This paper, which is authored by U. Ozguner, C. Stiller, and K. Redmill, reviews some technologies and approaches used for autonomous road vehicles. The paper evaluates different approaches utilized in the DARPA Grand Challenges of 2004 and 2005. The authors share their experience in the two challenges and present their methods in control, autonomy, sensing and situational understanding, which could impact many developments in this area.

A major component of future intelligent transportation systems, however, relies on vision-based systems for traffic observation, control, and real time management. The application of image processing and computer vision techniques has indeed been the most demanding and widely studied subject for road safety, traffic data collection and monitoring, autonomous vehicle guidance, as well as crash detection and prevention. Obviously, timely coverage of this important topic is well beyond the scope of this special issue. Nevertheless, adding to our wide-ranging collection of papers is an interesting article on the topic of traffic monitoring and enforcement systems. This article, which is authored by K. T. Song and J.-C. Tai, looks at the problem of misclassification of shadows and moving vehicles, which often causes serious errors in image analysis. In their approach, the authors propose a color-space ratio model for detecting shadow pixels in traffic imagery. Based on the experimental results, it concludes that traffic parameters such as traffic flow, vehicle speed, and vehicle turn ratio at an intersection can be obtained fairly accurately.

The modeling of human driving behavior in car-following and pedal operation is another interesting issue which is addressed in the next article by C. Miyajima, Y. Nishiwaki, K. Ozawa, T. Wakita, K. Itou, K. Takeda and F. Itakura. In this paper driver characteristics in car-following and gas/brake pedal operation patterns are statistically modeled using driving signals collected in a driving simulator and a field condition. Driver models are evaluated in driver identification experiments. The authors conclude that a driver model, based on spectral features of pedal operation signals, can achieve an identification rate of 76.8% for a field test with 276 drivers.

With a reduction in mechanical parts it is expected that a high percentage of future vehicle innovation will stem from silicon and software enabled technologies. As the role of the electronic systems in cars is rapidly increasing, we have dedicated the final contribution to this important topic. In the paper by Becker, Hübner, Juergen, Hettich, Constapel, Eisenmann, and Luka, a novel methodology for building dynamic and partial reconfigurable systems for Xilinx Virtex FPGA's is presented. In this paper the authors present an interesting approach for on-demand reconfiguration of automotive inner-cabin functions.

We hope that the readers will enjoy the collection of papers that have been selected for this special issue. We realize that there are a number of other topics that we are unable to cover due to the limited space and wide ranging topics in this field. However, this being the first special issue of its' kind, we certainly hope future Special Issues will follow.

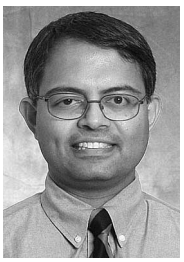
Finally, we would like to thank all the invited authors for their valuable contributions, as well as our reviewers for their time and efforts in providing timely feedback to the authors. We would also like to express our sincere gratitude to the Editor-in-Chief: Professor Fawwaz Ullaby, the editorial board, and especially Jim Calder, the Managing Editor, for the opportunity to put together this special issue. We also wish to thank Margery Meyer for her administrative assistance. ■

ABOUT THE GUEST EDITORS

Hamid Gharavi (Fellow, IEEE) received the Ph.D. degree from Loughborough University, Loughborough, U.K., in 1980. He joined AT&T Bell Laboratories, Holmdel, in 1982. He was then transferred to Bell Communications Research (Bellcore) after the AT&T-Bell divestiture, where he became a Consultant on video technology and a Distinguished Member of Research Staff. In 1993, he joined Loughborough University as Professor and Chair of Communication Engineering. Since September, 1998, he has been with the National Institute of Standards and Technology (NIST), U.S. Department of Commerce, Gaithersburg, MD.

He was a core member of the Study Group XV (Specialist Group on Coding for Visual Telephony) of the International Communications Standardization Body CCITT (ITU-T). He was selected as one of the six university academics to be appointed to the U.K. Government's Technology Foresight Panel in Communications to consider the future through 2015 and make recommendations for allocation of key research funds. His research interests include video/image transmission, wireless multimedia, mobile communications and third generation wireless systems, and mobile ad-hoc networks. He holds eight U.S. patents related to these topics.

Dr. Gharavi has been a Guest Editor for a number of special issues. He is the Deputy Editor-in-Chief of the IEEE TRANSACTIONS ON CAS FOR VIDEO TECHNOLOGY. Since January 2003, he has been serving as a member of the Editorial Board of the PROCEEDINGS OF THE IEEE. He received the Charles Babbage Premium Award of the Institute of Electronics and Radio Engineering in 1986 and the IEEE CAS Society Darlington Best Paper Award in 1989. Dr. Gharavi is a Distinguished Lecturer of the IEEE Communication Society.



K. Venkatesh Prasad (Member, IEEE) received the B.E. degree in Electronics and Communication from the National Institute of Technology, University of Madras (1980), an M.S.E.E. degree from the Indian Institute of Technology at Madras (1984), an M.S.E.E. degree with an emphasis in Computer Engineering from Washington State University (1987), and the Ph.D. degree in Electrical and Computer Engineering from Rutgers University (1990). He is the founding leader of Ford Motor Company's Infotronics Research & Advanced Engineering Group. He has over 30 journal or conference publications and book-chapters and holds 6 U.S. patents. He has delivered over 50 invited lectures, keynotes and seminars at universities & professional society meetings. Prasad has served as an external dissertation and thesis examiner at the University of Michigan and at the State University of New York, Buffalo. He has represented Ford Motor Company on several academic-industry partnerships including the Ford-Massachusetts Institute of Technology Strategic Alliance. Prasad is presently on the advisory board of Northwestern University's EECS department and Michigan State University's ECE department. From 1996 to 1998, he led research in the area of electronic imaging, pattern recognition and vehicle systems integration to support active safety and security applications. From 1992 to 1996, he was a Senior Research Scientist at the Ricoh California Research Center in Menlo Park, CA, working in the area of visual information processing and secure network transactions of digital documents. In the 1990–1992 period, Prasad was a postdoctoral associate at Rutgers University, a visiting researcher at the California Institute of Technology, working in the area of visual psychophysics. In 1992, he was in addition a Caltech faculty-affiliate at NASA's Jet Propulsion Laboratory in Pasadena, developing pattern recognition and computer vision algorithms for telerobotic surface inspection, with applications to the design of the International Space Station. He is a member of the Sigma Xi (the Scientific Research Society), Eta Kappa Nu (the Electrical Engineering Honor Society), and Tau Beta Pi (the Engineering Honor Society) and the ACM.

Petros A. Ioannou (Fellow, IEEE) received the B.Sc. degree with First Class Honors from University College, London, England, in 1978 and the M.S. and Ph.D. degrees from the University of Illinois, Urbana, in 1980 and 1982, respectively.

In 1982, Dr. Ioannou joined the Department of Electrical Engineering-Systems, University of Southern California, Los Angeles. He is currently a Professor in the same Department and the Director of the Center of Advanced Transportation Technologies. He also holds a courtesy appointment with the Department of Aerospace and Mechanical Engineering. His research interests are in the areas of adaptive control, neural networks, nonlinear systems, vehicle dynamics and control, intelligent transportation systems and marine transportation. He was visiting Professor at the University of Newcastle, Australia and the Australian National University in Canberra during parts of Fall of 1988, the Technical University of Crete in summer of 1992 and Fall of 2001 and served as the Dean of the School of Pure and Applied Science at the University of Cyprus in 1995. As the Dean, member of the Senate and member of some vital for the University of Cyprus committees he pioneered the establishment of the School of Engineering at the University of Cyprus.

In 1984 he was a recipient of the Outstanding Transactions Paper Award for his paper, "An Asymptotic Error Analysis of Identifiers and Adaptive Observers in the Presence of Parasitics," which appeared in the IEEE TRANSACTIONS ON AUTOMATIC CONTROL in August 1982. Dr. Ioannou is also the recipient of a 1985 Presidential Young Investigator Award for his research in Adaptive Control. He has been an Associate Editor for the IEEE TRANSACTIONS ON AUTOMATIC CONTROL, the International Journal of Control, Automatica and IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS. He also served as a member of the Control System society on IEEE ITS Council Committee and his center on advanced transportation technologies was a founding member of IVHS America which was later renamed ITS America. He is currently Associate Editor at Large of the IEEE TRANSACTIONS ON AUTOMATIC CONTROL and Chairman of the IFAC Technical Committee on Transportation Systems. He is a member of the Board of Governors of the IEEE Intelligent Transportation Society. He was one of the founders of the Mediterranean Control Association and a member of the Board of Governors. He was one of the founders of the IEEE Mediterranean Control Conference which has been taking place annually since 1992. He was the founder of the Center for Advanced Transportation Technologies and a co-founder of the University Transportation Center, METRANS, at the University of Southern California and California State University Long Beach.

Dr. Ioannou is a Fellow of IEEE, Fellow of the International Federation of Automatic Control (IFAC) and the author/co-author of 8 books and over 200 research papers in the area of controls, neural networks, nonlinear dynamical systems and intelligent transportation systems.